b) said two structural groups being separated from each other by an air gap,

c) and said two structural groups containing at least one soft magnetic body each,

d) partial areas of the surfaces of said at least two structural groups that lie adjacent to said air gap having inhomogeneous properties with regard to the magnetic flux,

e) wherein at least one said soft magnetic body has a region that is facing the air gap, said region facing the air gap having soft magnetic teeth that are disposed toward said air gap,

f) said region facing the air gap consisting of a material with higher magnetizability and/or higher saturation flux density than the remaining region of said soft magnetic body that is disposed more distant from said air gap,

g) said remaining region of said soft magnetic body belonging to the same said magnetic circuit,

h) and said remaining region of said soft magnetic body possessing in total a larger cross section in direction of the flux than the sum of said teeth that are disposed toward said air gap.

The first four features before the "wherein" (a - d) describe typical characteristics of a "reluctance machine" and are known. New for this type of machine is the combination of the next 4 characteristics (e - h).

The applicant respectfully points out that the object of Byrne (US Patent No. 4,698,537) does not possess all those characteristics the examiner describes in the response.

Correct is that Byrne is showing the characteristics a), b), c), and d). Byrne's machine is a **two-phase** reluctance machine as well, in which "self-starting irrespective of rotor position" is to be improved (col. 3, line 15 - 17). Another objective of Byrne is to provide a two-phase reluctance motor having favorable or acceptable noise and vibration characteristics.

Byrne shows stator poles with pole shoes, and each pole has a layer with a lower iron content, thus saturation of the soft magnetic body does not occur at the air gap but in this **depletion layer**.

The magnetic field intensity generated by the current of the stator coils can, due to the lower iron content of the "depletion layer", bring about only a **reduction of th flux**. This technical teaching is in sharp contrast to the approach of the present application to increase the amount of the air gap flux at the same air gap surface (design size).

Byrne pursues the **objective** of improving the start-up performance of a two-phase reluctance motor and to this end accepts that part of the field intensity decreases in the depletion layer of the rotor poles instead of generating torque in the air gap. This loss of magnetic field intensity in the depletion layer decreases flux density and thus superproportionally the capacity of the motor.

In comparison, the applicant pursues the **objective** of improving the capacity of the reluctance machine. He achieves this by utilizing high-quality magnetic materials in those areas of the magnetic circuit in which the flux flows through a reduced iron cross section. **Contrary** to Byrne, the applicant aims at avoiding the decrease of field intensity in the iron up to highest possible flux densities, and thus, to good effect, concentrate energy conversion in the air gap.

The distinction between Byrne and the present invention is particularly obvious in characteristic h) of claim 1 of the present application. Byrne does not show this characteristic h), but shows in the drawings poles with pole shoes, i.e. the flux cross section are smaller (!) in the areas that are more distant from the air gap than in the surface of the teeth that are disposed toward the air gap.

This is a significant difference for the power density of a reluctance machine.

The professional does **not** perceive from Byrne how to increase the effectiveness or the power density of reluctance motors. Instead, he receives a suggestion for the improvement of the start-up performance, which causes exactly the opposite, namely a decrease of effectiveness and power density.

In summary: Claim 1 is sharply delimited vis-a-vis Byrne by characteristic h). No other document contains the utilization of different soft magnetic materials in the same stator or rotor. A combination of other documents with Byrne does not provide a solution to claim 1 either, since Byrne is pursuing an opposite objective.

It is not possible to arrive at the solution presented in the present invention by modifying the electric machine with a depletion layer as suggested in Byrne.

Claim Rejections - USC § 103 (a):

The examiner rejects claims 2 - 5 under 35 USC § 103(a) as being unpatentable over Byrne in view of Fanning (EP 606 974 A1).

Byrne shows in Fig. 13 the cross section of a two-pole rotor that consists exclusively of grain oriented electric sheet. The flux cross section is larger at the air gap surface than in areas that are more distant from the air gap. Apart from this significant distinction, the soft magnetic body in Byrne's

embodiment does not consist of two different materials with different magnetization or saturation flux density.

The assembly of a soft magnetic body from grain oriented material (only in the teeth at the air gap) and non-grain oriented material (in the remaining soft magnetic body) is not shown by Byrne.

Nor does Fanning show such a differentiation!

Fanning shows in Fig. 6 - 8 a laminated stator comprising soft magnetic bodies stacked in tangential direction, and the thickness of the sheet increases as the radius increases.

Claim 4 of the present invention is dependent on claim 1. Fanning shows a totally different type of machine and not the features of claim 1.

The examiner rejects claims 6 under 35 USC § 102(b) as being unpatentable over Byrne in view of Fannning and Intermadox.

As explained above, Byrne shows how to improve the self-starting feature of a two-phase reluctance motor by a saturation zone of reduced cross section and/or reduced ferromagnetic density in a remaining region of said soft magnetic body that is disposed more distant from the air gap.

Neither Byrne nor Fanning disclose a stator having at least one spooled pole segment and two non-spooled pole segments.

Intermadox shows a stepping motor with a permanent magnet rotor and a stator that is laminated in axial direction, wherein said stator is composed of abutting annular sheet sectors (1) that are stacked in circumferential direction. The annular sheet sector is a part that is punched in one piece from a sheet. In Fig. 1, this piece covers one fourth (90°) of the circumference. A wide pole in the center of the sheet sectors is arranged between two half poles that, at the air gap, are approximately half as wide.

Contrary to this state of the art, which has been known since June 1978, the soft magnetic body in claim 6 of the present invention does not consist of multi-pole sectors, but of several individual parts. Pole segments and half pole segments are made as separate units. This additional separation of the soft magnetic body into smaller units creates the characteristic "pole segments consisting of grain oriented material". The applicant refers to the directional dependence of the magnetic properties of grain-oriented material. Already a deviation of the flux direction of only 20° from the direction of orientation decreases magnetizability up to 50%! Thus, it is a big difference whether a 90°-sector with several poles or individual pole segments directly are made of grain-oriented material.

The combination of these two characteristics:

a) Separation of the punched sheet into smaller units (single pole segments)

b) Utilization of grain-oriented material, which is not generally done in motors, is not shown by Intermadox.

This new combination provides considerable advantages:

1. At identical current in the pole coils, a 12% higher flux density can be realized at identical field strength in the teeth arranged at the air gap. Example: At a field strength of 2500 A/m, grain-oriented material can achieve 1.85 T and non-grain oriented material only 1.65 T. Since flux density contributes quadratic to force generation, torque increases by 25%!
2. At identical flux density in the pole core between the grooves, grain-oriented material causes losses that are 70% lower than those in non-grain oriented material. The efficiency of the motor can clearly increase, e.g. from 70 to 78%.
3. The coil can be wound tightly and very closely directly onto the pole core. The higher space factor lowers the losses in the winding.

The availability of grain-oriented electric sheet and sheet made of an iron-cobalt alloy are known since many decades to the person skilled in the art. Nevertheless, the partition of soft magnetic bodies in accordance with claim 1 and 6 is new. The invention could have been realized decades ago and the increase of power density and lowering of costs is surely the objective of many professionals. That is why the assertion the specific partition would be obvious for one skilled in the art is clearly refuted by the clear advantages with regard to power density and costs.

The applicant names 3 reasons for the patentability of claim 6:

- An increase of power density by more than 20% and concurrent clearly decreased losses are considerable improvements in electric machines.
- The state or the art is already 20 years old.
- The objective - increase of power density and reduction of losses - has occupied many persons in the past 20 years.

Nevertheless, the combination of characteristics a) and b) in claim 6 are new.

None of the documents - Byrne, Fanning, and Intermadox - show the characteristics of claim 1 and claim 6 of the present invention.

Reconsideration and allowance of the application is respectfully requested.

Respectfully submitted,

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